Confidential Draft Report

Health Impacts

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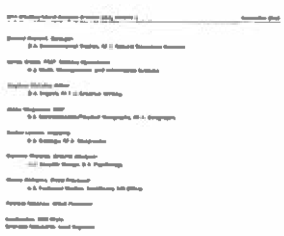
do read this -

COMBAT JET NOISE FROM LANDING AND TAKING OFF AT WHIDBEY ISLAND-OLF COUPEVILLE IS PERMANENTLY INJURING THE EXPOSED POPULATION

2017

This report supplements my prior report and provides a review of the Environmental Impact Statement (EIS) performed by Wyle Laboratories, a private company headquartered in the beltway around Washington DC. This private company is a huge international corporation that seems to do most of its work for the Department of Defense (DOD). It is not a scientific medical company, it is an engineering and logistic support company, not qualified to write a report on the health effects of aircraft noise on humans.

1. There are numerous failings in the Navy's EIS. First, the personnel who authored this EIS are not qualified to make judgments about the health effects of jet aircraft. Here is the list of so-called "experts" responsible for the authorship of this Environmental Impact Statement:



As you can see from this list there's not a single doctoral level scientist, medical doctor, environmental engineer, industrial hygienist or other qualified person to comment on the issues in this case. The non-auditory health risks were reviewed by Ben Sharp PhD. Internet information about Dr. Sharp is that he works at Wyle and is an auditory engineer. He is not a medical trained person and is not qualified to comment on anything but the sound measurement issues. Reading his work in appendix A, it is clear that he thinks a statistically, significant of 10%, 15% or 60% increase in death rates or risk of heart disease, hypertension and many other health problems that are outlined in the medical literature to occur from increased noise exposure is not important! His opinion is a shocking disregard for human life. Even more shocking is the fact that he failed to review all of the vast literature on the subject and reached an unsupportable conclusion that the literature on noise and non-auditory health effects is <u>not</u> settled science, but rather something so trivial that it should be ignored. The few articles he did review were glossed over in a cursory manner. The most comprehensive collection of studies performed by the World Health Organization (WHO) was not included in his review. There is a severe lack of qualification of all the Wyle Navy EIS authors including Dr. Sharp. These facts plus the lack of accurate noise level calculations leads me to suggest that the Wyle Laboratories EIS about Whidbey Island carries no weight whatsoever.

2. The issue in this case is impulse noise not noise sustained over long periods (1). The that the issue here is the jet aircraft flying low over the residents, creating unacceptable, acute, unusually high levels of **<u>impulse</u>** noise (acute noise at over 100 dB(A). During the year, there are thousands of fights occurring during the day, evening and night causing serious and permanent injury to those within the DNL map outlined by the Wyle group. The adverse effect affecting every exposed citizen is "annoyance", which interferes with the quiet enjoyment of life. The issue of annoyance has been studied in many published papers in the peer reviewed literature (2-25). But more serious is the increased noise induced damage to the hearing mechanism reduced hearing and tinnitus (i.e. cochlear injury) (26-33), disturbing sleep (34-49), raising blood pressure acutely and permanently (42, 43, 50-94), injuring the overall health (95), increasing cardiovascular diseases (47, 59, 61, 91, 92, 96-136), anxiety and other psychological problems (19, 24, 137-140), gastrointestinal disturbance (141-148), and reduced learning ability (especially in children) (24, 45, 65, 149-161). There

are a major injurious health effects arising from the frequent impulse noise events on Whidbey Island from the naval jets taking off, landing and flying over their homes at low altitudes. The levels of impulse noise, low frequency infranoise[1] and vibration on the exposed residents on Whidbey Island are simply unacceptable. It is urgent that the noise situation be changed to protect the permanent health damage as well as comfort of these citizens. As the following comment/report will show, the noise levels on Whidbey Island are a serious and real threat to the people exposed to these injurious levels of noise.

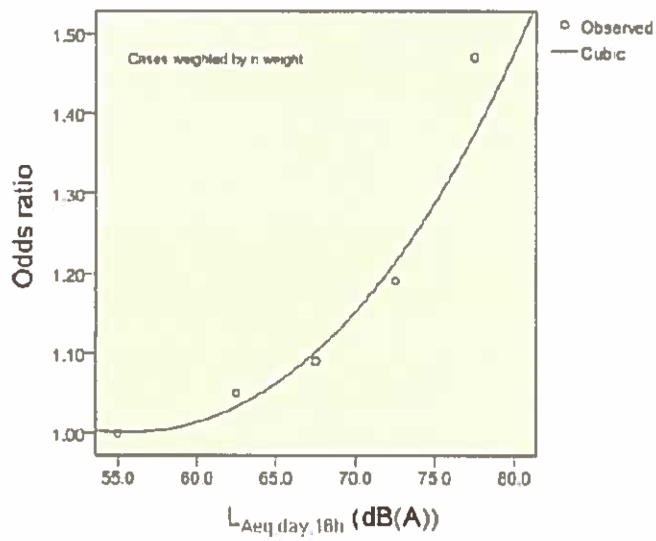
3. It is less desirable for the Wyle Laboratory personnel to take noise level estimates that they derive from their own proprietary sources rather than taking actual measurements of the sound levels at the Whidbey Island OLF. The plaintiffs' expert in this litigation has measured the sound levels and they are higher than the Wyle Laboratory estimates. In every case the Wyle Laboratory estimated sound levels are below levels that have actually been measured. The second major failing in the Navy's case.
4. If we look at the DNL maps provided in the EIS (Appendix A) we see the large portions of the island is experiencing level far above safe levels. According to the World Health Organization (WHO), the acceptable limit for the scientists at WHO is Leq_{16}[2] hour noise levels is 60 dB(A)(136). The level at night, 11 PM to 6 AM, should be lower. There are newer studies presented below that indicate increased adverse health effects, mainly hypertension, if noise is Leq_{24} 50 dB(A) due to the presence of elevated blood pressure in people exposed to noise above that level. Here is a quote from that 2011 monograph from WHO: "*The pooled estimates and CIs are shown graphically in Fig. 2.1 (descriptive studies) and Fig. 2.2 (analytical studies). The descriptive (cross-sectional) studies (Fig. 2.1) cover the sound level range of Lday,16h from > 50 to 70 dB(A), while the cohort and case-control studies (Fig. 2.2) cover the range from ≤ 60 to 80 dB(A). The two curves together can serve as a basis for estimating the exposure–response relationship. From Fig. 2.1, it can be seen that below 60 dB(A) for Lday,16h no noticeable increase in myocardial infarction risk is to be*

1. [1] Infranoise- sound waves with frequencies below the lower limit of human audibility
[2] Sound levels from 6 AM to 10 PM, sixteen hours.

detected. For noise levels greater than 60dB(A), the myocardial infarction risk increases (Fig. 2.1 and 2.2)."

5. Here is a graph from the WHO monograph with heart attack rates at Leq 16 60 dB(A) with an increasing dose response as the Leq16 rises.

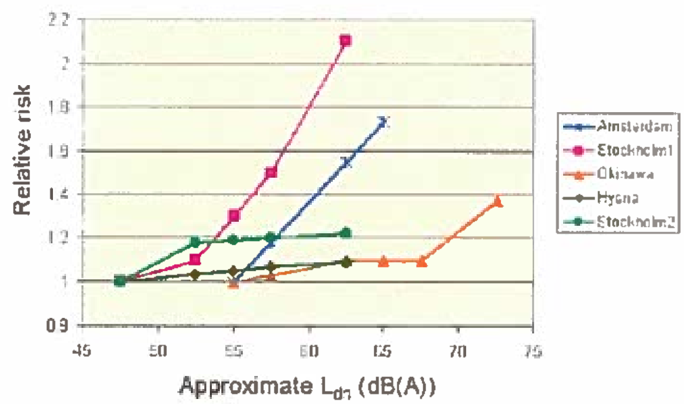
Fig. 2.3. Polynomial fit of the exposure-response relationship for road traffic noise and the incidence of myocardial infarction



Source: Babisch (21).

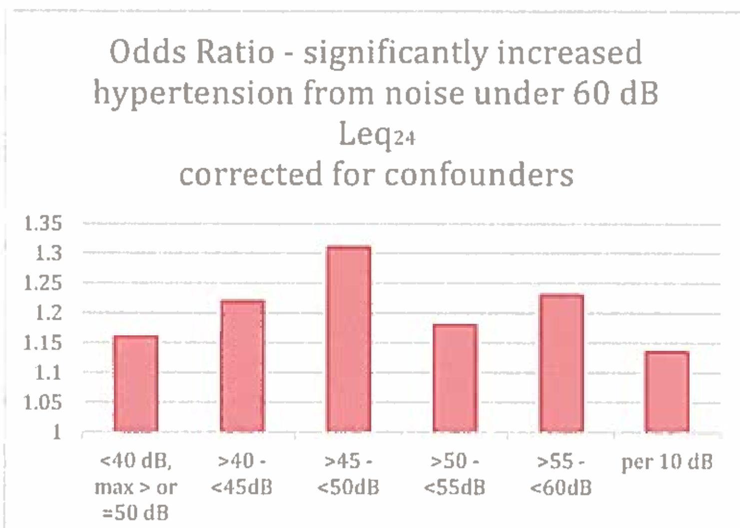
6. Hypertension is caused by excessive noise exposure; Ldn[3] is the noise metric in this graph. Here is a graph from the same WHO monograph.

Fig. 2.4. Association between aircraft noise and the prevalence or incidence of high blood pressure



Source: Babisch & Van Kamp (136).

7. Here is a graphic about significantly increased rates of hypertension caused from aircraft noise at Leq24 reported in 2016. The increased blood pressure occurs even under 40 dB if there are sound events during the night that exceed 50 dB such as an aircraft flying over the home of the subject. At 45 to 50 dB a 30% increase in blood pressure is seen (59).



3 Ldn is adds 10 dB for night measurements to allow for greater harm if the nosie occurs while people are trying to sleep or are sleeping.

8. The EIS from Wyle Laboratories was not reflective of an honest and thorough review of the scientific evidence that has been published over the last 53 years. The EIS has a brief and inadequate summary of the extremely important non-auditory health effects of noise citing only a few studies and ignores the dozens of references that I have provided in this and prior reports. There is a large body of scientific evidence which is consistent and scientifically derived indicating severe and permanent health effects from aircraft noise and other noise sources as well. Studies of noise and health effects includes aircraft, traffic and railroad as sources. It is good science to include these studies as well as the aircraft studies. The noise from all sources creates the same health effects. As you will see the issue is noise regardless of the source of that noise.
9. For example, the Wyle authors used a PhD named Ben Sharp (no mention of the field in which he has a PhD) reviewed a few articles on non-auditory effects of noise. He quoted one study by Haralabidis 2008 suggesting a statistically significant increase in BP from noise but fails to quote the methods, results and conclusion of this study. This study did 24-hour blood pressure monitoring of subjects sleeping. They then subjected to subjects while sleeping to a sound pressure 35 dB inside their home from aircraft noise. Dr. Sharp ridiculed the results by saying that they were not a large enough increasing blood pressure to be significant. Even though the changes from their baseline blood pressure was statistically significant. The authors went on to note acute increase in blood pressure are associated with chronic blood pressure and therefore the results were highly significant adding weight to many other studies proving that even low level noise exposure can result in significant hypertension and subsequent cardiovascular disease. Here's a quote from that article in its conclusion(162):
"*Within the HYENA project we found effects of long-term noise exposure on the prevalence of hypertension*[18] *and the acute effects reported here. Absence of short-term habituation to the cardiovascular effects of noise, especially those during sleep, found here and also reported before,*[13,16,39] *as well as evidence from studies on sleep-disorder which indicate that repeated arousals are associated with a sustained increase in*

daytime BP,[40] support a link between acute and long-term effects of noise exposure on hypertension[41,42] and cardiovascular disease,[43] in line with the general stress theory.[44]"

10. I would suggest that Dr. Sharp is completely and utterly incorrect in his view that these low-level noise (i.e. >35 dB inside a house) do disturb sleep and that disturbance is very important to the health of the person. Note the maximums of noise in the Greek airport that would most closely approximate the very short term sound events (Whidbey events are louder) in Whidbey Island as found by JGL noise studies near the OLF and representative of higher levels of noise than estimated by the Wyle Laboratory EIS. Here is a graphic of the noise levels from Haralabidis et al:

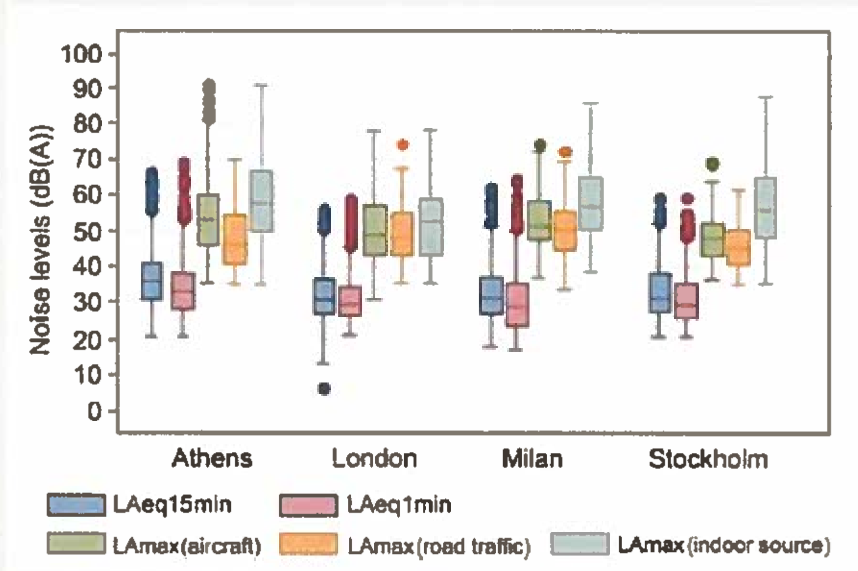


Figure 1 Box plots of the various noise indicators measured during the study night

11. The Haralabidis study indicate that the presence of aircraft noise a sudden, although slight increase in the sound pressure during sleep is causing an adverse health effect and is not trivial as opined by Dr. Sharp. The finding of an event during the night that resulted in a spike from sound pressure >35 dB created a statistically significant rise of blood pressure of 6.2 mm systolic & 7.4 mm diastolic over 15 minute intervals when an aircraft event occurred.

12. A 2001 Swedish study reported statistically significant increased prevalence of hypertension in people around an airport. The sound levels are far lower than in Whidbey Island. The maximum sound levels were above 72 dB(A) but in between sound levels were lower <55 dB(A). This like other studies indicate that the impulse noise adds to the stress response that startles the person, an unexpected rapidly rising relatively loud sound creates more stress and thus not only immediate increase in blood pressure but also permanent high blood pressure. Here is a table from that study:

Table 3 Prevalence of hypertension among residents with exposure to equal energy (FBN) and maximum (MNL) levels of aircraft noise, stratified by sex, age, and hearing loss

	n	Hypertension	%	n	Hypertension	%	POR*	95% CI*
	FBN <55 dBA			FBN >55 dBA				
Men	1291	199	15	64	14	22	1.7	0.9 to 3.3
Women	1530	196	13	74	13	18	1.4	0.8 to 2.8
<55 y	1975	166	8	96	10	10	1.2	0.6 to 2.5
≥56 y	846	229	27	42	17	40	1.9	1.0 to 3.7
Hearing loss	517	110	21	23	4	17	0.7	0.2 to 2.4
No hearing loss	2284	277	12	115	23	20	2.0	1.2 to 3.2
	MNL <72 dBA			MNL >72 dBA				
Men	1285	198	15	70	15	21	1.8	0.9 to 3.4
Women	1530	195	13	74	14	19	1.7	0.9 to 3.2
<55 y	1969	165	8	102	11	11	1.4	0.7 to 2.7
≥56 y	846	228	27	42	18	43	2.2	1.1 to 4.1
Hearing loss	517	109	21	23	5	22	1.1	0.4 to 3.3
No hearing loss	2279	276	12	120	24	20	2.1	1.3 to 3.4

*Prevalence odds ratio (95% CI) adjusted for age, sex, smoking, and education (except when stratified by sex).

13. For comparison, here are the noise levels in these studies we can compare the noise measured by JGL at the Whidbey Island OLF. The sound attenuation inside a home from the flyover by the Growler jets varies depending on several factors. A reasonable sound attenuation inside buildings estimate would be between ~15 dB and ~25 dB according to the Wyle EIS. The indoor noise levels rang from an average in the five locations, after attenuation from 99 to 109 dB or 83 to 93 dB(A). This estimate does not take into account the greater impact of noise while sleeping, which would raise the levels impact by 10 dB(A). When a person is asleep they are more prone to blood pressure spikes than the same sound pressure event during waking hours. The Growler jets are in fact creating very high sound pressures, which are much higher than the levels at a civilian airport. Here is JGL data:

Table 1. Noise level statistics at each measurement location.

Statistic	Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Maximum A-weighted Level (dBA)	119.2	113.4	115.7	114.3	81.1
Maximum Un-Weighted Peak Level (dB)	134.2	126.7	130.6	131.4	101.8
Session SEL (dBA)	128.5	124.5	122.7	127.7	92.1
Session Duration (minutes)	39	58	45	36	25
Total Jet Flyovers	35	43	26	28	8
Average SEL per Jet Flyover (dBA)	113.1	108.2	108.5	113.2	83.1

These sound measurements indicate a health damaging noise event for the neighbors to the Coupeville OLF thousands of times per year.

14. The Wyle Group used the occupational exposure limit of 90 dBA for an eight-hour exposure from OSHA as a reference. Wyle claims that this is level that causes permanent hearing injury. The OSHA level is not an appropriate metric that has no relevance to the neighborhood around the airfield. The use of hearing loss as the only permanent health related end point used by the Wyle group is wrong. A serious investigation of health effects from a noise exposure must take into consideration the more sensitive end points such blood pressure, learning impairment, sleeping, mental health, cardiovascular effects to name only a few documented health effects of noise below an environmental level of 90 dB. Hearing loss does occur and it occurs at lower than 90 dB in children and if there is an impulse noise above 90 dB. The main point is that hearing loss is not the most sensitive health end point impacted by noise, especially sudden, unexpected and sharply rising noise levels as we have in this case.
15. Here is a quote from a meta-analysis that shows the safety oriented end point will result in noise levels far lower than 90 dB(A). The issue is non-auditory health effects, which have been shown to occur at lower levels than hearing loss (163): "*We identified 10 studies on road and aircraft noise exposure conducted since the mid-1990s , providing a total of 12 risk estimates. Pooled relative risk for IHD was 1.06 (1.03–1.09) per 10dB increase in noise exposure with the linear exposure–response starting at 50 dB*". This is 50 dB metric is outside the building and is not predicated on 40 years of exposure. People exposed to 90

dB(A) noise outside their home will have 6% increase or 24% of people will have hypertension because the rate of increase is for EACH 10 dB(A) increase in sound level.

16. There are several studies that link aircraft noise to increase occurrence of hypertension(58, 59, 61, 87, 123). A study quoted by Dr. Sharp is Evrard published in 2015, showed that there is a statistically significant increase in: Coronary Heart Disease – Odds Ratio 1.23; Cardiovascular Disease – Odds Ratio 1.18; Myocardial Infarction – Odds Ratio 1.31; for **each 10 dB increase** in the range of 42 to 64 dB. Dr. Sharp seems unaware of the fact that such findings are highly significant. Any occupational and environmental medical doctor would agree that these findings are highly significant and not trivial. Hypertension causes heart disease and strokes. It is not trivial or of no importance, especially when you realize that noise has many other undesirable adverse health effects.
17. Another study by Evrard et al in 2016 (87) notes the following data in a table:

Table 3 Effects estimates of various aircraft noise indicators* on hypertension and BP in men

	Hypertension		Diastolic BP		Systolic BP	
Indicator of exposure	OR† (95% CI)	p Value	Increase in mm Hg‡ (95% CI)	p Value	Increase in mm Hg‡ (95% CI)	p Value
L_{den} (dB(A))	1.48 (1.00 to 1.97)	0.04	1.86 (0.40 to 3.30)	0.01	2.37 (0.16 to 4.59)	0.04
$L_{Aeq,\ 16\ hours}$ (dB(A))	1.34 (0.90 to 1.79)	0.10	1.51 (0.11 to 2.92)	0.03	2.19 (0.05 to 4.34)	0.05
L_{night} (dB(A))	1.34 (1.00 to 1.97)	0.04	1.67 (0.34 to 3.00)	0.01	2.17 (0.13 to 4.19)	0.04

Bold values are statistically significant $p \leq 0.05$.
*Per 10 dB(A) increase.
†Adjusted for age, gender, BMI, physical activity, alcohol consumption and professional activity.
‡Adjusted for age, gender, BMI, physical activity, alcohol consumption, professional activity and hypertensive medication.
BMI, body mass index; BP, blood pressure.

This table makes the point that very low sound levels cause a significant increase in risk for hypertension from aircraft noise at a civilian airport where noise levels are much less than Whidbey Island. The range of sound levels was from 42 to 64 dB(A). (Again the increase I for each increment of 10 dB(A)). This data is similar to the other studies noted above and below.

18. In a study in Holland by Franssen, the same pattern emerges(42). Here are the noise levels around this civilian airport:

Table 2 Description of the aircraft noise exposure measures in the study population

Exposure measure	Range	Average	SD
L_{den}	41–76 dB(A)	51.3	3.1
$L_{Aeq,\ 22\text{-}23\ h}$	36–70 dB(A)	44.3	4.1
$L_{Aeq,\ 23\text{-}07\ h}$	32–65 dB(A)	37.9	4.0
Kosten units	0–64 Kosten units	17.3	6.8

Franssen published this table showing many health problems including hypertension and sleep disturbance with the sound levels much lower than experienced by the plaintiffs;

Table 5 Odds ratios (OR) and 95% confidence intervals (CI) after multiple logistic regression of health indicators, in relation to various noise exposure measures per 10 dB(A) increase in noise levels, controlling for potential determinants

Health indicator	n_{total}	$n_{affected}$	Noise measure	OR	95% CI
Poor self-rated health (single question)	10412	1969	L_{den}	1.23	1.04 to 1.46
			$L_{Aeq,\ 23\text{-}07\ hrs}$	1.05	0.91 to 1.22
Poor self-rated health (VOEG score)	9887	1871	L_{den}	1.21	1.02 to 1.43
			$L_{Aeq,\ 23\text{-}07\ hrs}$	1.08	0.94 to 1.25
Medication for cardiovascular diseases/increased blood pressure	10105	1316	L_{den}	1.30	1.06 to 1.60
			$L_{Aeq,\ 23\text{-}07\ hrs}$	1.13	0.94 to 1.35
Prescribed sleep medication or sedatives	7240	516	L_{den}	1.25	0.93 to 1.68
			$L_{Aeq,\ 23\text{-}07\ hrs}$	0.91	0.70 to 1.18
			$L_{Aeq,\ 22\text{-}23\ hrs}$	1.26	0.99 to 1.60
Non-prescribed sleep medication or sedatives	7240	309	L_{den}	2.34	1.63 to 3.35
			$L_{Aeq,\ 23\text{-}07\ hrs}$	1.20	0.87 to 1.65
			$L_{Aeq,\ 22\text{-}23\ hrs}$	1.72	1.27 to 2.32
Frequent use of sleep medication or sedatives	7175	189	L_{den}	1.02	0.63 to 1.65
			$L_{Aeq,\ 23\text{-}07\ hrs}$	1.36	0.91 to 2.04
			$L_{Aeq,\ 22\text{-}23\ hrs}$	1.15	0.78 to 1.70

19. A later study by Eriksson in 2007 reported a statistically significant incidence of hypertension from aircraft noise (88). Here is a table from that study as part of consistent findings in numerous studies:

TABLE 3. Association Between Aircraft Noise Exposure and Cumulative Incidence of Hypertension Among Men in Stockholm* Following Exclusion of Those Smoking or Using Snuff Directly Preceding Blood Pressure Measurements

			Crude		Adjusted†	
Noise Exposure	No.	No. with Hypertension	RR	(95% CI)	RR	(95% CI)
Energy-averaged aircraft noise level						
Continuous [per 5 dB(A)]			1.17	(1.07–1.29)	1.15	(1.05–1.25)
Dichotomous						
<50 dB(A)‡	1281	375	1.00		1.00	
≥50 dB(A)	301	117	1.33	(1.13–1.57)	1.29	(1.11–1.50)
Maximum aircraft noise level						
Continuous [per 3 dB(A)]			1.16	(1.06–1.27)	1.15	(1.06–1.25)
Dichotomous						
<70 dB(A)‡	1354	401	1.00		1.00	
≥70 dB(A)	228	91	1.35	(1.13–1.61)	1.32	(1.12–1.55)

*Based on subjects with complete data on exposure and confounding variables.
†Adjusted for age and BMI.
‡Reference category.

20. The HYENA project from the Haralabidis study (81, 162) investigated short-term changes of noise levels on blood pressure and heart rate during night-time sleep in subjects living near airports. Both blood pressure levels and heart rate increased with higher noise levels, independently of the noise source and of the sequence of the measurement during sleep time, which indicates absence of habituation during the study night. The project also found effects of long-term noise exposure on the prevalence of hypertension and acute these acute effects or arousals. There is a consistent absense of short-term habituation to cardiovascular effects of noise, as described in the HYENA project and and other studies (47, 48) as well as sleep-disorder evidence leading to increase in BP (164) . These authors indicate this supports a link between acute and long-term effects of noise on hypertension and cardiovascular disease(63, 88, 102)
21. The Wyle group consistently relies upon the "DNL." In 2011, they put together a 2011 report titled "Updating and Supplementing the Day-Night Average Sound Level (DNL). Discussed is the creation of DNL, including the reliance on the Schultz's curve, and described as "a dose-response curve that was easy to apply to quantify noise impact." Contradictory to the recent report on Whidbey, the Wyle group says "While the Schultz curve is a valuable tool, it tends to give the impression that community noise impact is well represented by a single dose-response curve based on DNL. The curve is often treated as a black box, to be derived from social surveys and improved by curve fits of additional data. With so many data points in the current form, and the rather small differences with improved versions, it is questionable how much might be gained from continuing that kind of approach." This means that including the peak levels is extremely important in supplementing the average. They go on to discuss, "annoyance is a multivariate function that includes many effects such as Speech interference; Sleep disturbance; Task interference; Impairment of classroom learning; Non-auditory health effects; and Aversive effects on emotion and tranquility." None of these items are properly researched or taken into account within the current EIS and the few literature citations is not accurately reported in the 2016 draft concerning Whidbey Island EIS for the US Navy.

22. Additionally, the Wyle group evaluated 628 social surveys on the response of residents to noise, 1943-2008. Wyle provides a number of insights and analyses in their study of surveys, the importance of surveys, and provide recommendations to be included in future surveys. In referring to surveys, they make the observations "But those involve aircraft not typical of today's commercial fleet in the United States, may have been analyzed as much as possible, and/or are not structured such that models like Equations (2) or (3) can be fitted. If results are required that have not already been developed from prior surveys, then it is expected that a new survey that is designed for the candidate metrics would be required." Whidbey Island is an obvious candidate for a community survey conducted by a reputable epidemiologist and medical doctor, yet no community survey was performed within the context of the current EIS.
23. None of the learning interference, speech intelligibility, nonauditory effects noted for school children noted tha fact that the children live in the neighborhood and are in fact exposed outside of the school. The school children all live in residences within the contours of high sound pressures. An 8-hour school day is not the proper measurement for noise exposure of these children.
24. **The effects of noise on children and the susceptibility of children to health effects has been disregarded completely by the Wyle group.** A large review article reported an adverse effect on children from chronic noise exposure. The children had elevations of resting blood pressure, attentional deficiencies, and deficits in reading (165). Other effects include diminished task motivation, deficits in auditory disctractors, poorer memory when high information processing demands are present, and deficits in infant cognitive development. The attached Appendix B highlights the tables from this study showing the large number of studies and research on this subject. The efect on children is more distrubing than the effect on adults beccause the noise factor is reducing the child's ability to fulfill their full potential academically, not to mention adverse health effects tha will require life-long and increased medical care.
25. Cohen in 1980 found that children from noisy schools have higher blood pressure and are more likely to give up on a task than children from quiet (166). Increase

in time of exposure led to children being more distractible. He also found that prolonged noise exposure affects cognitive processes and there is a lack of adaptability in children shown in both blood pressure and cognitive processes. Cohen followed up to this article in 1981 establishing the stability of these effects over time and the lack of adaptation to noise over extended periods of time (167).

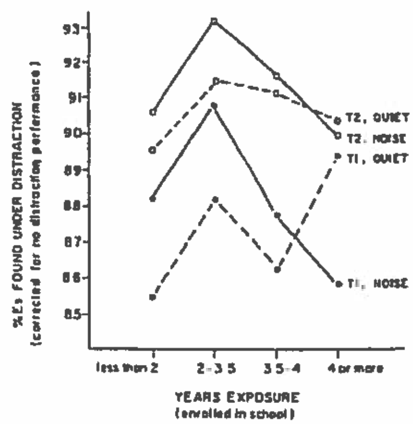


Figure 1. Distractibility at T1 and at T2 as a function of school noise level and duration of exposure (Each period on the number of year's of exposure coordinate represents one quarter (based on quartiles) of the sample For example, 25% of the sample were enrolled in school for less than 2 years)

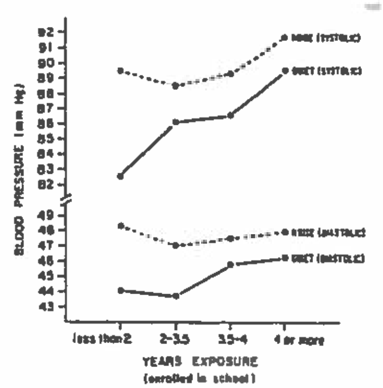


Figure 2 Systolic and diastolic blood pressure as a function of school noise level and duration of exposure Each period on the number of years of exposure coordinate represents one quarter (based on quartiles) of the sample For example, 25% of the sample were enrolled in school for less than 2 years. (From "Physiological, Motivational, and Cognitive Effects of Aircraft Noise on Children: Moving from the Laboratory to the Field" by Sheldon Cohen, Gary W. Evans, David S. Krantz, and Daniel Stokols, *American Psychologist*, 1980, 35, 231–243 Copyright 1980 by the American Psychological Association Reprinted by permission)

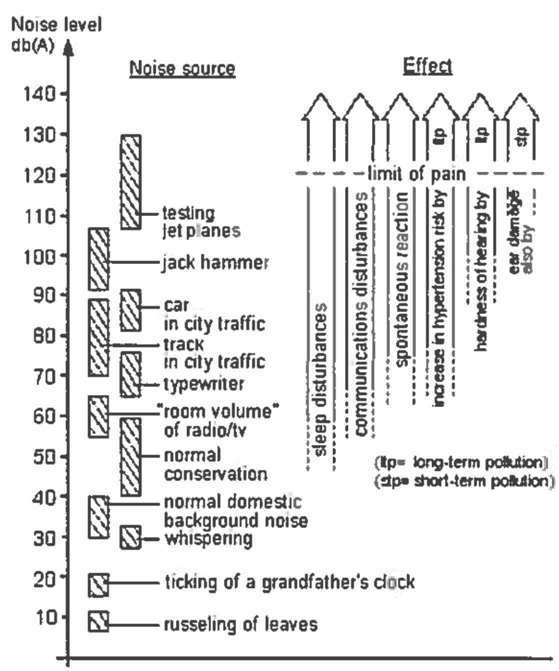
Blood pressure and the effect of noise on annoyance, distractability and performance lasts. Noisy school children were poorer at solving test puzzle and tasks.

26. Results from a nonauditory effects study show that children living in noisier areas of residential communities are subject to stress even if at modest levels (both noise and "stress")(168). The study examined multimethodological indices of stress among children living under 50 dB or above 60 dB but within ambient community noise levels. "Children residing in noisier areas of communities have marginally higher resting systolic blood pressure, greater heart rate reactivity to an acute stressor, and higher overnight cortisol levels indicative of modestly elevated physiological stress."

27. Psychophysiological activation, particularly blood pressure, is correlated with airport noise exposure among children. A number of articles describe both acute and chronic exposure leads to blood pressure increases in children near source exposure (17, 114, 169, 170)

The next section of this report describes the serious and well documented adverse health effects of noise. This report will also describe the health effects that have almost certainly already occurred from years of noise pollution from thousands of take off and landings of the combat jets in Whidbey Island. The issue in this case is whether there is evidence that this noise pollution actually harms people. The Navy sponsored 2016 EIS has suggested or states that there is no proof of harm to health from the jet noise. Or, if there is harm, it is negligible according to the Wyle Laboratory personnel.

1. Noise pollution is unwanted or harmful sound that intrudes upon human activity. Here is a graphic that describes where jet aircraft noise compares with other loud noise.



This figure illustrates levels of sound pressure or noise from different sources and explains the weighting of dB(A) (103)

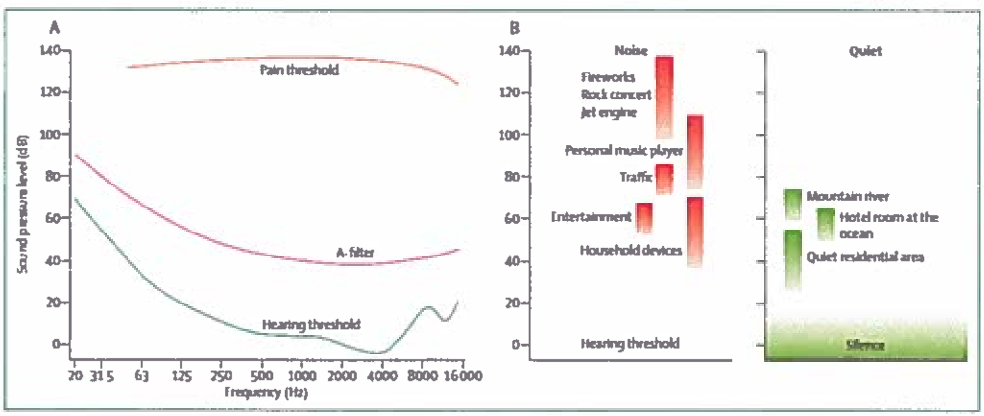


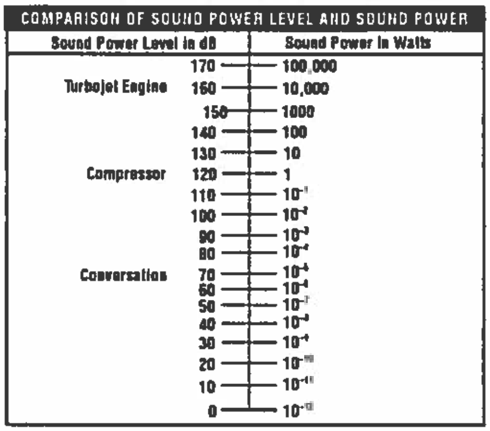
***Figure 1:* Sound pressure levels**
(A) The sensitivity of the auditory system depends on sound frequency and sensitivity is highest between 2000 Hz and 5000 Hz (green line). The A-filter (dark red line) is a frequency-weighting of sound pressure levels that mimics the sensitivity of the auditory system (eg, low-frequency sounds contribute little to the A-weighted dB level). (B) A-weighted sound pressure levels for several environmental sounds, emphasising that whether or not a sound is perceived as noise depends largely on the context and the individual, and is only partly determined by its sound pressure levels. For example, spectators attending a rock concert might not perceive the music as noise, whereas residents in the vicinity of the venue might call it noise, even though sound pressure levels are much lower there than for inside.

2. Noise is measured in the amount of pressure occurring at different levels and is noted in decibels (dB) on log scale. An increase from 90 to 100 dB is not a 10% increase; it is a 10-fold increase in the pressure. There are two basic causative types of health effect impacts from noise pollution: (a) those arising from short term, but high intensity sound (impulse noise), and (b) those arising from longer term exposure to lower levels of sound. The first type manifest in close encounters with military jets landing and taking off such as we have at the Whidbey

Island Navy OLF and Air Station(118). The Michalak study showed severe increases in blood pressure in elderly subjects from military jets flying low over residences. The study by Ising et al showed adverse effects on auditory function and blood pressure in children from low flying military jets (12, 114). Rapid acute changes in sound pressure/noise is more damaging than steady sound levels. Here is a quote from Ising 1990: *"Our findings support the contention that auditory effects of MLAF (Military Low Aircraft Flight) noise are correlated with the Lmax rather than the Leq. In both the 75 m area and the 150 m area, the Leq values (68 dB(A) and 59 dB(A), respectively) were far below the minimum level for noise induced hearing loss (80 - 85 dB(A)). However, according to Spreng (1988), the difference in maximum noise levels (125 dB(A) and 112 dB(A), respectively could explain the area difference audiometric findings."*

3. Noise level exposure is strongly associated with permanent hypertension, heart attacks, anxiety, depression, gastrointestinal changes, and learning impairment. The association in epidemiological studies is not the only evidence that noise causes adverse health effects; there are animal and mechanistic studies that explain how noise pollution at the levels and circumstance present on Central Whidbey Island causes these health problems. The weight of the evidence provided shows that noise is causative of serious injuries.
4. Although noise pollution is *annoying, annoyance* is by no means the only adverse health effect. Decades of research have shown that the issue of noise pollution is a serious, disabling and even a life-threatening issue. The loud, short-term noise from the Navy jet flying over Whidbey Island is an issue of life and death. The noise exposure levels that have been documented from low flying combat jets in this

case and in the literature, are in the range that is certain to injure some members of the exposed population, particularly the elderly and children.



5. Both JGL and AICUZ measured annual sound levels well above 70 dB in the plaintiffs' neighborhood. In a Navy document[4] on environmental impact on the residents near Coupeville OLF it states, *"Residential land uses are normally considered incompatible with noise levels above 65 DNL."* Even more egregious, the Navy states there is no scientific evidence that noise that occurs from combat jets taking-off and landing that has shown the noise pollution at OLF Coupeville to be hazardous to health.
6. In fact, the noise impact from combat jets, like the situation in this case, has been studied. The high-level noise exposure from a combat jet flying over a person has been shown in a scientific study to causes a significant increase blood pressure and "shock" to the body with some individuals becoming acutely ill from the noise. If the noise rises and subsides quickly, such as occurs in this case when there are multiple jets flying one after the other, the blood pressures do not return to the pre-noise level and continues to climb higher and higher. This is shown

[4] Page I-14, Final Environmental Assessment for the Transition of Expeditionary EA-6B Prowler Squadrons to EA-18G Growler at Naval Air StationWhidbey Island, Oak Harbor, Washington. October 2012.

in the graphic above from a published, peer reviewed study of combat jet noise by Michalak and colleagues (118).

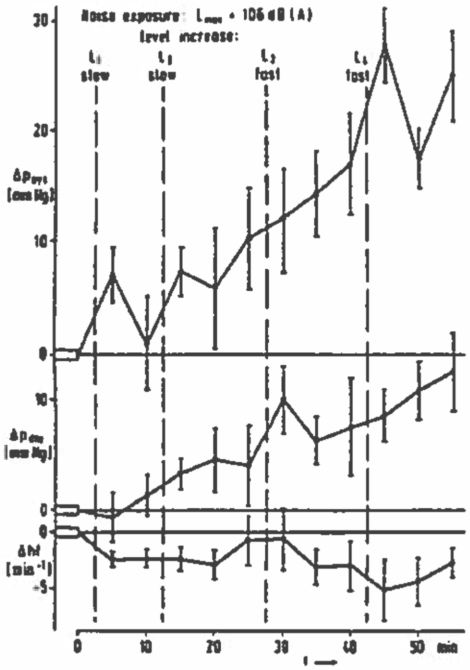


Fig. 3. Time response of blood pressure and heart rate changes after low-altitude flight noise exposure on Day 0 in subjects who had a maximum systolic blood pressure increase of more than 25 mm Hg. The differences for each person are related to the averaged initial values before the first noise exposure. The averaged values and standard errors of those differences ($n = 8$) are presented

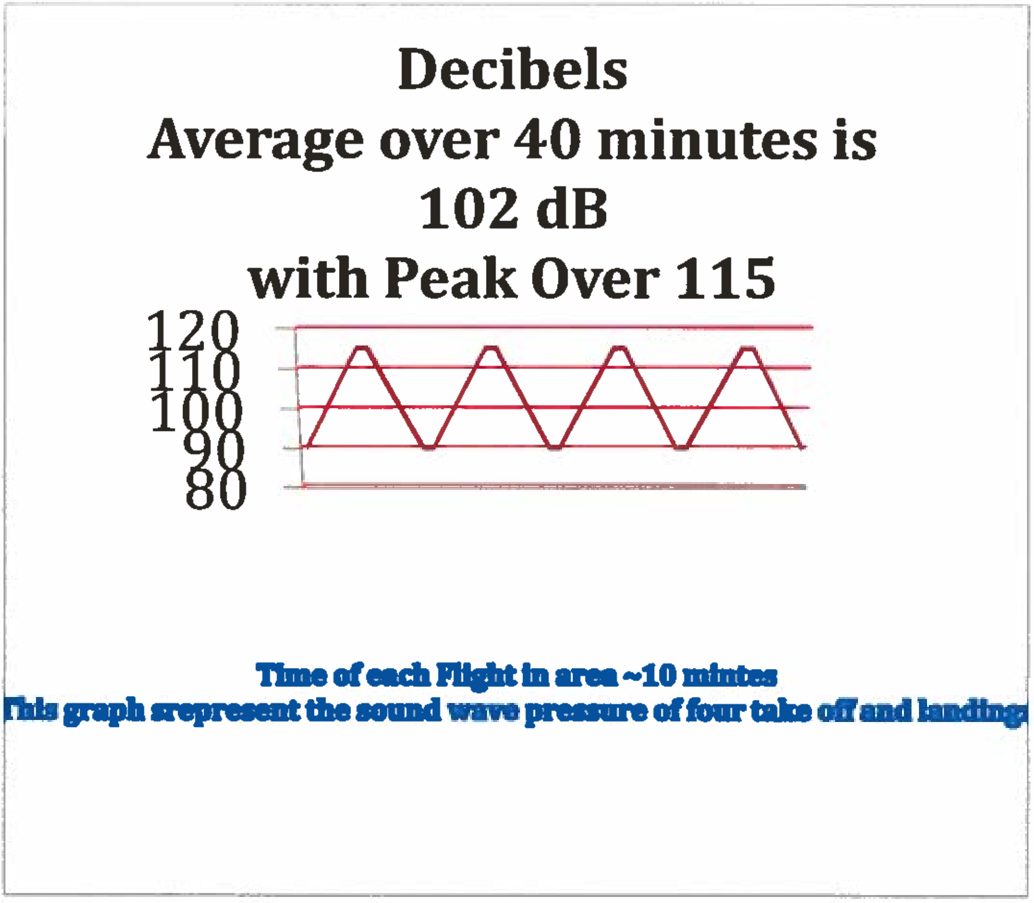
7. The Michalak study of combat jet noise documented that the people exposed to combat jet aircraft noise significantly raised their blood pressure and the brief noise exposure at these levels made some of the test subjects sick. The dBA levels used in this experiment were 106, 110 and 112 dBA. The graphic above used 106 dB and as you can see the blood pressure rises significantly at that level. The "shock" reaction and acute illness occurred when the noise level rose quickly, as occurs around the Coupeville OLF. When the noise rose quickly, by 30 dB over 0.4 seconds, as opposed to 4.0 seconds, 10 to 20% of the subjects experienced "shock" and sickness. Two study subjects had 40 mm rise in systolic blood pressure after four fly-overs at a maximum of 106

dBA. These authors noted that repeated exposures were additive, each exposure drove the BP higher, especially in the subjects who had an initial higher BP response. The presence of these blood pressure elevations is most dangerous, especially if it occurs repetitively for months and years. Severe acute increases in blood pressure are itself dangerous. Acute elevations of blood pressure can trigger strokes and heart attacks. In this case the people near Coupeville OLF have been exposed for years. We do not know if there have been strokes or heart attacks triggered by these fly overs, but it is likely that such events have occurred. Michalak et al noted that elderly people are more sensitive to adverse effects from combat jet fly over noise. Wyle laboratories suggest that community surveys be conducted where there are noise pollution problems.

8. The development of noise-induced hypertension discussed below has occurred in community noise exposures of adults and children and in noise exposed workers. Several community studies have stressed that aircraft noise is more harmful than traffic noise. The noise patterns that have been studied in communities and in factories do show adverse effects, even when the noise is rising and falling as it does in Coupeville. It is the repeated stress reactions that lead to permanent hypertension. Noise induces an acute stress reaction, which over time becomes permanent.
9. The Michalak research examined people living in noisier versus quieter areas. They found that in girls, ages 10 to 13 that lived in the noisier area compared to the quieter, reported higher blood pressure by an average of 9 mm systolic. Such elevation of blood pressure can lead to permanent hypertension.
10. In addition, the subjects of the combat jet experiment became sensitized to the jet noise pattern. Becoming sensitized or developing permanent conditioned response meant that when the test subjects heard the jet noise at a lower level intensity, they responded with a

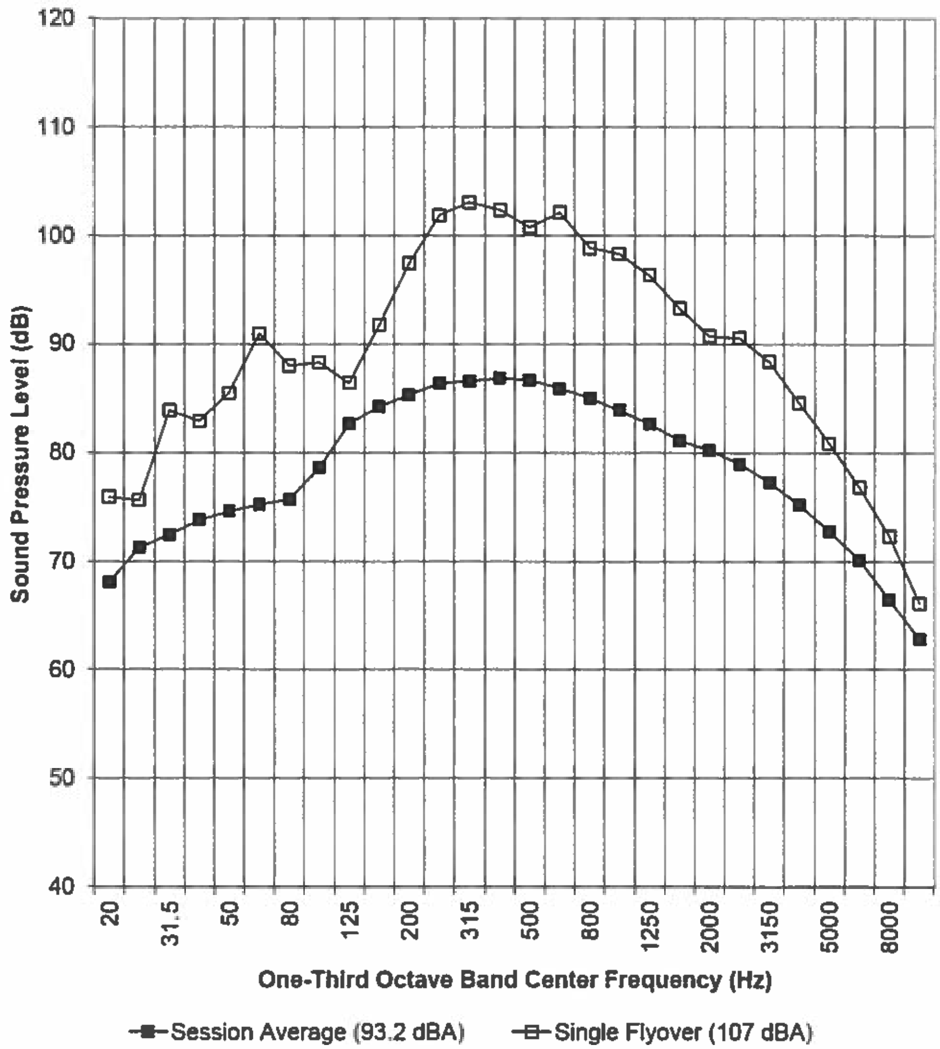
similar rise in blood pressure to the high level of noise. This sensitization or conditioned response occurred even though the level of noise was not elevated to the point that it would have been predicted to cause the blood pressure to rise. This study is very relevant for the Whidbey Island population. The conditioned reflex means that when they hear the jet approaching the BP rises even before the jet noise reaches the subject.

11. Michalak's study refutes the EIS study and the naval flight station commander, Captain M. K. Nortier's, opinion that there is no evidence of health effects from the type of noise generated by the Navy's Growler jets flying, landing and taking off from Coupeville OLF.
12. The noise pattern at Central Whidbey Island has been measured and the noise levels are higher than the Michalak study. The noise measured at OLF Coupeville is illustrated by this graphic derived from JGL's study:



Here is the graph of the sound frequency pattern from the study of noise at OLF Coupeville area:

Whidbey Island Jet Noise
Growler Noise Spectrum at Position 1



13. An exhaustive monograph by the World Health Organization (WHO) on the subject of adverse health consequences of auditory and non-auditory effects of noise writes in the abstract (103):

"Our understanding of molecular mechanisms involved in noise-induced hair-cell and nerve damage has substantially increased, and preventive and therapeutic drugs will probably become available within 10 years. Evidence of the non-auditory effects of environmental noise exposure on public health is growing. Observational and experimental studies have shown that noise exposure leads to annoyance, disturbs sleep and causes daytime sleepiness, affects patient outcomes and staff performance in hospitals, increases the occurrence of hypertension and cardiovascular disease, and impairs cognitive performance in schoolchildren."

World Health Organization (WHO) summarized the evidence of the non-auditory adverse health effects in these two paragraphs from page 16:

"Non-auditory health effects of noise have been studied in humans and animals for several decades, using laboratory and empirical methods. Biological reaction models have been derived, based on the general stress concept (17,23–30). Noise is a nonspecific stressor that arouses the autonomous nervous system and the endocrine system (9,11–14,31,32) (C. Maschke & K. Hecht, unpublished data, 2005). A neuro-endocrinological definition of stress is that it is a state that threatens homeostatic or adaptable systems in the body (16,33,34). Increased allostatic load is associated with various diseases, including ischaemic heart disease (35). The epidemiological reasoning is based on three facts. First, experimental studies in the laboratory have been carried out for a long time and revealed an increased vegetative and endocrine reactivity during periods of exposure (1,36–70). However, the question regarding long-term effects of chronic noise exposure cannot be answered from short-term experiments. Second, animal studies have shown manifest disorders in species exposed to high levels of noise for a long time (71–83). However, effects in humans and animals cannot be directly compared, particularly because two pathways may be relevant – the direct effect due to nervous innervation and the indirect effect due to the cognitive perception of the sound; the latter is certainly different in humans. Furthermore, noise

levels in animal studies were higher than in ambient situations. Third, occupational studies have shown health disorders in workers chronically exposed to noise for many years (20,84–98). However, noise levels were higher than in the ambient environment. Epidemiological research has therefore been carried out with respect to community noise levels to test the hypothesis and to quantify the risk.

Among other non-auditory health end-points, short-term changes in circulation, including blood pressure, heart rate, cardiac output and vasoconstriction, as well as stress hormones (epinephrine, norepinephrine and corticosteroids), have been studied in experimental settings for many years (32,99). Classical biological risk factors have been shown to be elevated in subjects that were exposed to high levels of noise (44,54,79,100–111)."

There are millions of disability lost life years from noise pollution as illustrated by this figure from the WHO study(103):

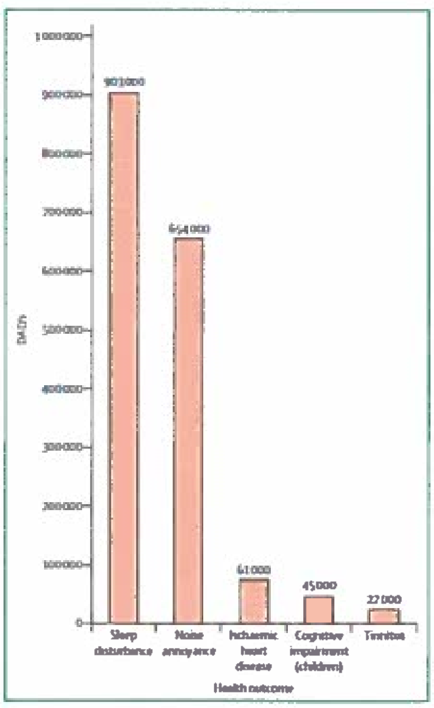


Figure 2: DALYs attributed to environmental noise exposure in Europe. According to WHO,[14] more than 1 million healthy life years (DALYs) are lost annually because of environmental noise exposure in European A-member states alone. Most of these DALYs can be attributed to noise-induced sleep disturbance and annoyance. DALYs= Disability-adjusted life years.

14. WHO utilized a very large database of studies and derives conclusions from hundreds of studies that note serious, adverse health effects from even modest elevations of noise levels. Most of the studies of interest have found injurious effects at sound levels far lower than those experienced by the residents of Whidbey Island. The residents experiencing noise pollution from the jets landing and taking off at OLF Coupeville on Whidbey Island are experiencing the adverse health effects that we would expect including: annoyance, hearing loss, sleep disturbance and cardiovascular problems. The WHO monograph illustrates the serious nature of what has happened and still is happening to the citizens living near the Coupeville landing field. The impact on the health of these people is certain to be devastating and has likely already increased morbidity and even shortened their lives.
15. The community of Central Whidbey Island is adversely impacted by the noise from combat jets landing and taking off from their practice airfield. In 1978 the US EPA published a monograph on noise pollution and recommended the community noise levels not exceed 70 decibels to prevent hearing loss (171). They included a graphic, which indicates that a community with significant noise pollution does react vigorously and justifiably if there are elevated noise levels. Here is the graphic from that monograph.

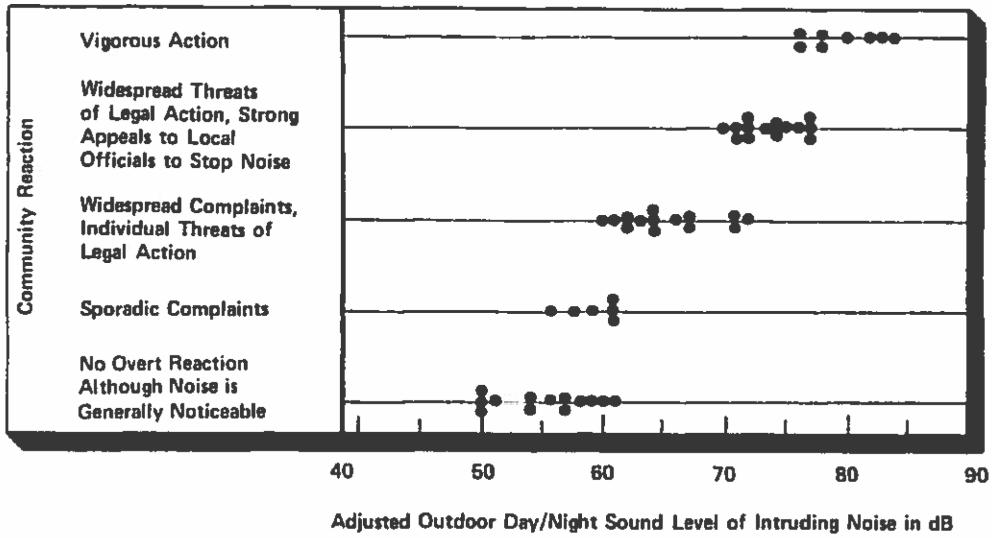


FIGURE 11. COMBINED DATA FROM COMMUNITY CASE STUDIES ADJUSTED FOR CONDITIONS OF EXPOSURE

This graphic suggests that until the community noise levels are less than 70 dB, the community will be up in arms. The JGL studies of the sound levels near the landing field are indicative of noise levels that results in vigorous community reaction.

16. A study of noise and whole body vibration [5] finds that the combination of noise and vibration is additive, causing more health problems than with noise alone (172). These authors also looked at the susceptibility of some people to be more impacted by noise and vibration. The people who were under chronic medical care by a doctor labeled as unhealthy had a greater adverse reaction to the noise and vibration than healthy people. Here is a table from that study.

[5] The residents near the Coupeville OLF that whole body vibration and shaking of building, is caused by the Growler Jets.

TABLE 2

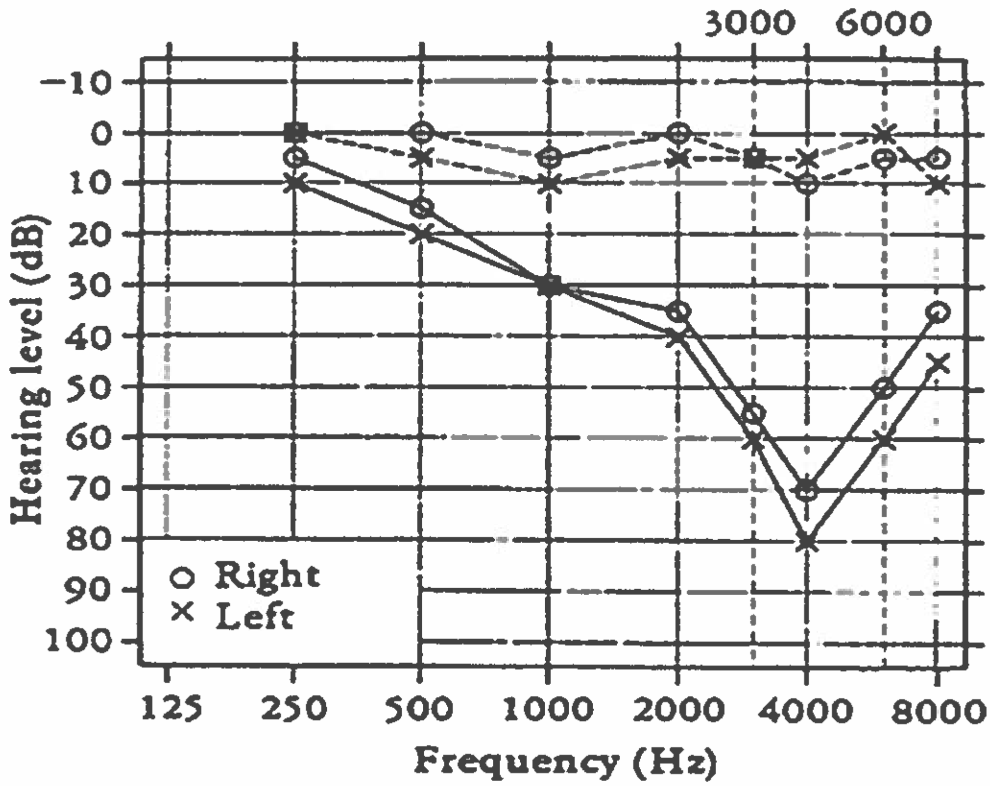
Average number of positive responses to 190 questions by health status

	Healthy	Unhealthy
Number of respondents	893	294
Average number of positive responses	29·6	42·6**

The difference in the average number is significant at the 1% level(**) compared to healthy respondents, according to the Student *t*-test (two-tailed).

By no means does this imply that the healthy people did not have adverse non-auditory responses to the noise and vibration energy. Rather, the noise and vibration significantly increases the harm to those already sick

17. There is evidence that the OLF Coupeville area residents have already developed noise induced hearing loss. A loss of hearing in the higher frequencies that is typical of noise induced hearing loss. Here is the pattern that we see in one of the residents who has been tested and we would see if we tested other residents, a drop of hearing at 4000 Hz.

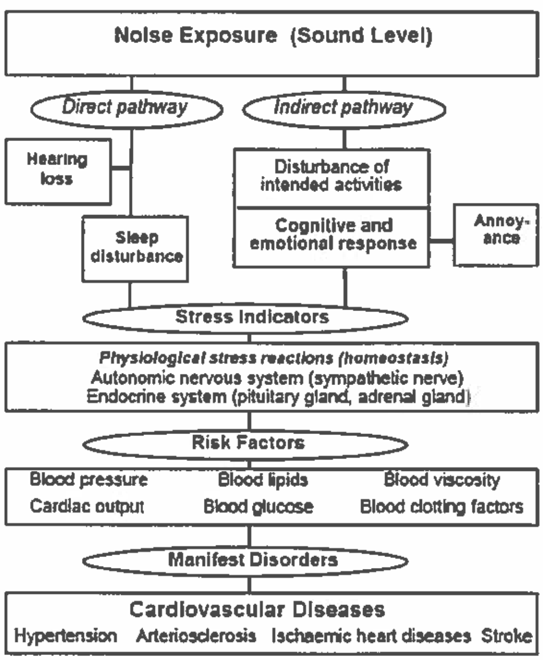


18. The 2011World Health Organization (WHO) published the monograph quoted above that reviewed the literature on adverse auditory and non-auditory health effects caused by noise. WHO concluded that in addition to hearing loss, non-auditory health effects were a serious public health and environmental health problem(136). WHO quoted numerous high quality studies to document the deadly effect of noise on cardiovascular health.
19. The study by Babisch and colleagues in Germany provided a meta-analysis of increase levels of noise causing cardiovascular problems, heart attacks and ischemic heart disease. Here is a graphic from a 2014 article that illustrates the pathways (101). Below is a table from Babisch showing an increased risk of ischemic heart disease and heart attacks (myocardial infarction) arising in the context of noise exposure levels far below the noise levels documented on Whidbey Island when the jets land and take off at OLF Coupeville.

Study type (country)	Reference	Number of subjects	Number of cases	Response rate (%)	Covariates	Age (years)	Exposure assessment [dB (A)]	Health outcome
Caerphilly-CS (United Kingdom)	Babisch *et al.* 1993[29]	M: 2.512	M: 438	89	A, G, B, C, S, E, P, M, F, O	45-59	L_{Aeq16h} ≤55->65	Prevalent IHD (clinical)
Speedwell-CS (United Kingdom)	Babisch *et al.* 1993[29]	M: 2.348	M: 340	92	A, G, B, C, S, P, F, O	46-63	L_{Aeq16h} ≤55->65	Prevalent IHD (clinical)
Berlin I-hCC (Germany)-hCC	Babisch *et al.* 1994[26]	M: 243	M: 109	Cases: 89 Controls: 87	A, G, B, C, S	41-70	L_{Aeq16h} ≤60->75	Incident MI (clinical)
Berlin II-pCC (Germany)	Babisch *et al.* 1994[26]	M: 4.035	M: 645	Cases: 91 Controls: 64	A, G, B, C, S, M, O	31-70	L_{Aeq16h} ≤60->75	Incident MI (clinical)
Berlin II-CS (Germany)	Babisch *et al.* 1994[26]	M: 2.375	M: 206	64	A, G, B, C, S, M, O	31-70	L_{Aeq16h} ≤60->75	Prevalent MI (self-reported)
Tokyo-CS (Japan)	Yoshida *et al.* 1997[30]	F: 3.950	F: 305	73	A, G	20-60	L_{Aeq16h} ≤55->70	Prevalent CHD (self-reported)
Caerphilly-CO (United Kingdom)	Babisch *et al.* 1999[25]	M: 2.369	M: 281	Follow-up: 94	A, G, B, C, S, E, P, M, F, O	45-59	L_{Aeq16h} ≤55-70	Incident MI (clinical)
Speedwell-CO (United Kingdom)	Babisch *et al.* 1999[25]	M: 2.330	M: 290	Follow-up: 78	A, G, B, C, S, P, F, O	46-63	L_{Aeq16h} ≤55-70	Incident MI (clinical)
Berlin III-hCC (Germany)	Babisch *et al.* 2005[27]	M: 3.054 F: 1.061	M: 1.528 F: 354	Cases+controls: 84	A, G, B, C, S, M, F, O	20-69	L_{Aeq16h} ≤60->70	Incident MI (clinical)
Netherlands-CO (The Netherlands)	Beelen *et al.* 2009[14]	M+F: 105.269	M+F: 3,089	Follow-up: high (death register)	A, G, C, S, O, Nb	55-69	$L_{Aeq, mean}$ ≤50->65	Incident IHD (mortality)
Stockholm-pCC (Sweden)	Selander *et al.* 2009[13]	M+F: 3.518	M+F: 1.466	Cases: 72 controls: 70	A, G, C, B, S, P, N, O	45-70	L_{Aeq24h} <50-≥60	Incident MI (clinical)
Stockholm Gothenborg Malmo-CS (Sweden)	Eriksson *et al.* 2012[15]	M+F: 2.498	M+F: 161	59	A, G, C, S, N	18-80	L_{den} <50-≥65	Prevalent CVD (self-reported)
Vancouver-CO (Canada)	Gan *et al.* 2012[16]	M: 189.713 F: 222.707	M+F: 3.095	Follow-up: high (death register)	A, G, C, O, Nb	45-85	L_{den} ≤58->70	Incident CHD (mortality)
Copenhagen Aarhus-CO (Denmark)	Sorensen *et al.* 2012[17]	M: 24.294 F: 26.319	M: 1.184 F: 416	Follow-up: 89	A, G, B, C, S, E, P, N, O	50-64	L_{den} ≤50->70	Incident MI (clinical)

[a]Maximum LAeq of weighted Lday, Levening, Lnight. [b]Studies provided adjusted and non-adjusted results regarding air pollution. M = Males, F = Females, MI = Myocardial infarction, CHD = Coronary heart disease, IHD = Ischaemic heart disease, CVD = Cardiovascular disease, CS = Cross-sectional, CO = Cohort, hCC = Hospital case-control, pCC = Population case-control, Covariates: A = Age, G = Gender, S = Smoking, B = Body mass index, P = Physical activity, C = Social class indicator, E = Alcohol intake, F = Family history of MI, M = Marital status, N = Air pollution, O = Other. Non-adjusted results were used in this meta-analysis.

Another graphic from Babisch shows the multiple cardiovascular effects of noise:



20. The adverse effect of environmental traffic noise on cardiovascular health remains even when the impact from concomitant air pollution is controlled (90). There are numerous studies, analyzed by the weight of the evidence, that provide overwhelming evidence that noise exposure causes hypertension in both adults(50, 52, 53, 56, 57, 60, 62, 64, 66, 67, 75, 76, 80-82, 84-86, 88, 90, 93, 94, 97, 101, 103, 119, 173-181) and children(34, 65, 74, 103, 168). The duration and the dB level of the noise act together, the higher the exposure the shorter the duration of exposure that is needed. Noise induces a reaction in the body of immediate increase in many elements that raise blood pressure and other risk factors for cardiovascular damage, such as blood lipids. I include a bibliography of relevant articles that give a sense of the amount of information we have on this aspect of noise related personal injury (15, 35, 51-53, 56, 62, 67, 68, 84, 85, 92, 99, 103, 113, 119, 174, 177, 178, 181-185). Several studies document aircraft noise, specifically, as a cause of the adverse effects of noise.
21. One study of noise notes a dose response of noise and HBP. There is a large increase in hypertension prevalence as the sound pressure (SPL) increases (50). Here is a table from that study:

A dose response relation for noise induced hypertension

Table 2 Sound pressure level and prevalence of hypertension in female textile mill workers

SPL dB(A)	*No with hypertension*	*Total*	*Hypertensive prevalence (%)*
104	25	164	15·2
96	25	294	8·5
86–90	18	428	4·2
75–80	11	215	5·1
Total	79	1101	7·2

22. As with all diseases there is a genetic susceptibility factor. Not everyone exposed to noise develops clinically significant hypertension, cardiovascular disease, or other adverse effect. There is a well-described phenomenon of gene-environment interaction. An excellent prospective study followed hundreds of subjects exposed to noise over a 20-year period and measured their hypertensive susceptibility gene sub-types. A gene known to increase the risk of high blood pressure (HBP) is the angiotensin TT gene. In this study the presence of the TT subtype and noise exposure were synergistic for developing hypertension (82). The noise levels experienced by these subjects were less than the Central Whidney Island subjects. Duration of exposure in some subjects was similar. Contrary to The Navy's EIS, it does not take 40 years of noise exposure at 90dB to cause hearing loss.
23. The effect of noise at night when people are trying to sleep occurs at very low level and there is growing evidence that night time noise is devastating to health. Here is a graphic from the WHO monograph on night time, **<u>outside</u>** noise:

Table 5.4
Effects of different levels of night noise on the population's health[2]

Average night noise level over a year $L_{night,outside}$	Health effects observed in the population
Up to 30 dB	Although individual sensitivities and circumstances may differ, it appears that up to this level no substantial biological effects are observed. $L_{night,outside}$ of 30 dB is equivalent to the NOEL for night noise.
30 to 40 dB	A number of effects on sleep are observed from this range: body movements, awakening, self-reported sleep disturbance, arousals. The intensity of the effect depends on the nature of the source and the number of events. Vulnerable groups (for example children, the chronically ill and the elderly) are more susceptible. However, even in the worst cases the effects seem modest. $L_{night,outside}$ of 40 dB is equivalent to the LOAEL for night noise.
40 to 55 dB	Adverse health effects are observed among the exposed population. Many people have to adapt their lives to cope with the noise at night. Vulnerable groups are more severely affected.
Above 55 dB	The situation is considered increasingly dangerous for public health. Adverse health effects occur frequently, a sizeable proportion of the population is highly annoyed and sleep-disturbed. There is evidence that the risk of cardiovascular disease increases.

24. If we were to study the Whidbey Island residents that have been exposed to the very high levels of aircraft noise at night we would find an increase in the prevalence and severity of hypertension and cardiovascular disease.
25. Noise-disturbed sleep is linked with multiple health effects. Sleep is a physiological state required for normal recuperation by the body and systems. Reduction and disruption are detrimental. In a clinical review of research and literature, Muzet finds sleep awakenings and sleep stage modifications that occur between 45 and 55 dB and above over the long-term can lead to detrimental health impacts (37). Partial sleep deprivation induces tiredness, increases a low vigilance state, and reduces both daytime performance and the overall quality of life (41). Sleep deprivation activates levels of stress known to be linked to hypertension, cardiovascular disease and other severe medical

problems.

26. The presence of increased noise especially aircraft noise pollution has been associated with learning problems in children (186). Here is a table showing this association.

Table 2. Multilevel Model Parameter Estimates for the Impact of Aircraft and Road Traffic Noise at School on Children's Cognitive Performance and Health Outcomes, United Kingdom RANCH Project, 2001–2003

Variable	Aircraft and Road Traffic Noise at School Adjusted for Sociodemographic Factors[a] — Original Sample ($n = 960$)				Air Pollution Subsample ($n = 719$)			
	No. of Participants	β[b]	95% CI	P Value	No. of Participants	β[b]	95% CI	P Value
Cognitive outcomes								
Reading comprehension	864				651			
Road traffic noise		−0.001	−0.014, 0.011	0.80		−0.002	−0.017, 0.013	0.77
Aircraft noise		−0.010	−0.020, 0.0005	0.06		−0.011	−0.022, 0.00021	0.05
Recognition memory	844				641			
Road traffic noise		−0.012	−0.046, 0.021	0.47		−0.012	−0.048, 0.023	0.50
Aircraft noise		−0.035*	−0.061, −0.009	0.01		−0.042*	−0.069, −0.016	<0.01
Information recall	837				638			
Road traffic noise		0.039	−0.030, 0.108	0.27		0.040	−0.014, 0.094	0.14
Aircraft noise		−0.025	−0.080, 0.028	0.35		−0.040	−0.082, 0.001	0.06
Conceptual recall	834				636			
Road traffic noise		−0.007	−0.008, 0.022	0.37		0.007	−0.007, 0.021	0.31
Aircraft noise		−0.011	−0.023, 0.001	<0.01		−0.015*	−0.025, −0.004	<0.01
Working memory	785				580			
Road traffic noise		0.038	−0.063, 0.142	0.45		0.036	−0.096, 0.167	0.60
Aircraft noise		−0.004	−0.063, 0.142	0.92		0.00077	−0.096, 0.097	0.99
Health outcomes								
Psychological distress	842				634			
Road traffic noise		−0.025	−0.084, 0.032	0.38		−0.030	−0.093, 0.033	0.35
Aircraft noise		−0.017	−0.064, 0.029	0.46		−0.023	−0.073, 0.026	0.36
Self-rated health	868				655			
Road traffic noise		0.0006	−0.024, 0.025	0.96		0.003	−0.024, 0.030	0.82
Aircraft noise		0.002	−0.018, 0.022	0.83		0.007	−0.015, 0.028	0.54
Systolic blood pressure	351				276			
Road traffic noise		−0.09	−0.25, 0.08	0.22		−0.092	−0.303, 0.118	0.39
Aircraft noise		0.02	−0.12, 0.15	0.77		0.024	−0.131, 0.179	0.76
Diastolic blood pressure	351				276			
Road traffic noise		0.02	−0.11, 0.15	0.76		0.042	−0.125, 0.211	0.61
Aircraft noise		0.01	−0.09, 0.12	0.83		0.019	−0.104, 0.144	0.75

27. The levels of noise that interfere with children's learning are far lower than the levels at central Whidbey Island. There are schools in the noise impacted area near OLF Coupeville. Those children are surely suffering from impaired learning ability due to the frequent loud noise impacting their schools. In the above study they review a number of studies that document serious noise induced impairment of children's cognitive function. The intermittent high and rapid increase and decrease in noise levels that are typical of aircraft noise cause more problem with learning than a continuous noise source (187). The

presence of an unexpected sound is more disruptive than a sound of the same level that is expected. The brain responds to an unexpected sound because we are hard wired to detect an unusual or unintended sound as possible danger. Here is a quote from Banbury et al. on this issue (188).

"When considering the functional character of the sense of hearing – as opposed to vision – one is struck by its omnidirectional nature and the fact that it has the capacity to receive information at almost all times, even in darkness or during sleep. To these features of hearing is added a superlative capacity to respond to change. Part of the evolutionary refinement of hearing has been its capacity to respond to sharp changes in energy, which might be associated with danger in the environment. Given these qualities, it comes as no surprise that hearing has been dubbed "the sentinel of the senses." This capacity to capture attention even while a person is otherwise engaged can be exploited usefully for the purpose of designing alarms. However, the same sentinel capacity carries with it the disadvantage that our attention will be captured by sounds with no relevance or significance, even when we are intent on concentrating on something else."

28. The non-auditory adverse health effects of sound include stomach ulcers and other GI problems(189). Here is a graphic from Jorge da Fonseca et al. study of rats exposed to low frequency noise (LFN) <200Hz. The sound pressure from the Growler jets shows the highest sound pressure (dB) at these lower Hz/frequencies (see JGL's study). The rats experienced severe damage to stomach tissue.

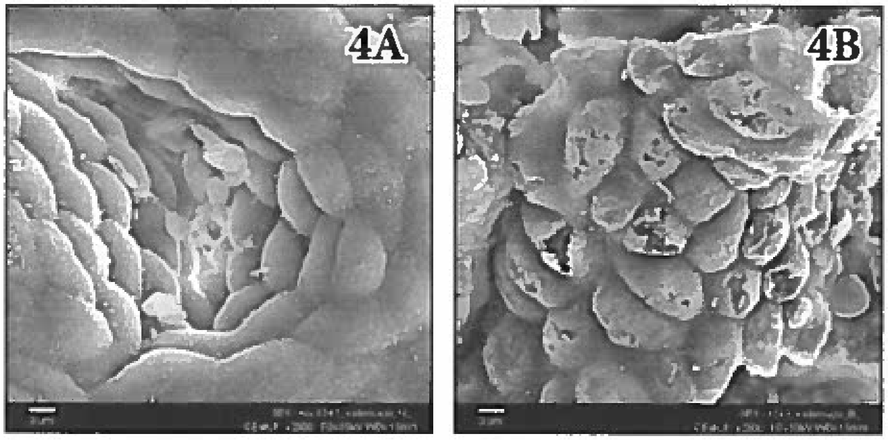


Fig. 4. *SEM micrographs of epithelial layer of rat stomach (x 2,000). Normal aspects from control rat (Fig. 4a) and massive cell death observed in noise-exposed rat (Fig. 4b).*

The effect on stomach tissue was due to direct impact of the sound waves on the tissue. The Growler jets have a pattern of noise frequency that includes sound wave frequency down to 10 Hz. The study of Low Frequency Noise (LFN) explains why a person feels the high level of sound in their gut. It is likely that the gastrointestinal system of the Whidbey residents is impacted adversely by the frequent loud noise especially the lower frequency sounds. Studies of people and dogs exposed to loud noise have altered stomach acid secretions and ulcers (190). Patients' with Crohn's disease have sensorineural hearing loss at 4000 Hz, the exact type of hearing loss caused by noise (143, 191-193). The authors of the Crohn's disease studies have not ascribed the sensorineural hearing loss to noise injury but rather to autoimmune damage to the auditory nerve. The pattern of hearing loss is only caused by noise exposure! The finding of gastrointestinal damage in the studies of noise-induced injury to the intestinal tract makes it more likely that the Crohn's disease is caused by noise exposure in susceptible people.

29. Low Frequency Noise and noise frequencies below audible ranges, i.e. infranoise, have received less attention than audible noise. However,

there is evidence that it adds to the risk, especially the risk of non-auditory effects such as gastrointestinal effects. One study found increased GI effects even though the subjects were wearing ear protection, presumably not experiencing threshold shifts in hearing. The subjects still felt the non-auditory effects of noise, experiencing GI symptoms including diarrhea (194).

30. Studies of non-auditory effects of noise pollution causing gastrointestinal problems include a number of animal and human studies that establish GI upset as a likely and common problem for the noise impacted residents of Whidbey Island (142, 144, 146, 147, 190, 195-201).
31. The residents of Whidbey Island are experiencing sudden, unexpected, incontrollable, unwanted loud sounds. The noise and vibration is intense enough to cause unacceptable interference in their lives. In addition to the serious physical effects caused by the jet noise, the citizens of the OLP Coupeville area are denied the quiet enjoyment of life.
32. The science quoted above indicates that there is solid uncontroverted evidence that health problems have occurred in the exposed population. If the flights continue more health damage will occur. My methodology to reach conclusions about the effect of noise and health is based on the weight of the evidence. There are nine considerations when determining causation, often referred to as the weight of the evidence (202). The nine "Hill viewpoints" are fulfilled in the case of noise and health impairment. The viewpoints are (1) strength of association i.e. increased relative risk or similar metric showing a higher than expected occurrence of disease or end-point of interest, (2) consistency i.e. the studies are generally in agreement, (3) specificity i.e. do the studies show the same effect in various populations, (4) temporality i.e. did the exposure occur before the outcome, (5) biological gradient i.e. is there a dose response, (6) plausibility i.e. the

cause and effect consistent with known biology, (7) coherence i.e. does the body of evidence make sense without major confounding (other effects that would occur with the cause of interest), (8) experiment i.e. do animal studies or laboratory simulations reflect a similar outcome and is there a mechanism that links the cause and effect, and (9) analogy i.e. does the cause have parallels from other cause and effect paradigms such as in this case other forms of stress causing similar outcomes. All of these factors <u>do not</u> need to be present to establish causation. In this case all of the elements are present, providing sufficient evidence for a conclusion that excessive noise causes the serious illnesses; auditory, cardiovascular, learning, psychiatric, neurological and gastrointestinal systems illnesses. The very high short term and repeated noise pollution present in and around OLF Coupeville on Whidbey Island from the jets landing and taking off is a certain cause of ill health. Noise pollution from the combat jet exercises must cease immediately to protect the health of the people living there.

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Appendix A – Sound Pressure Levels from Wyle EIS

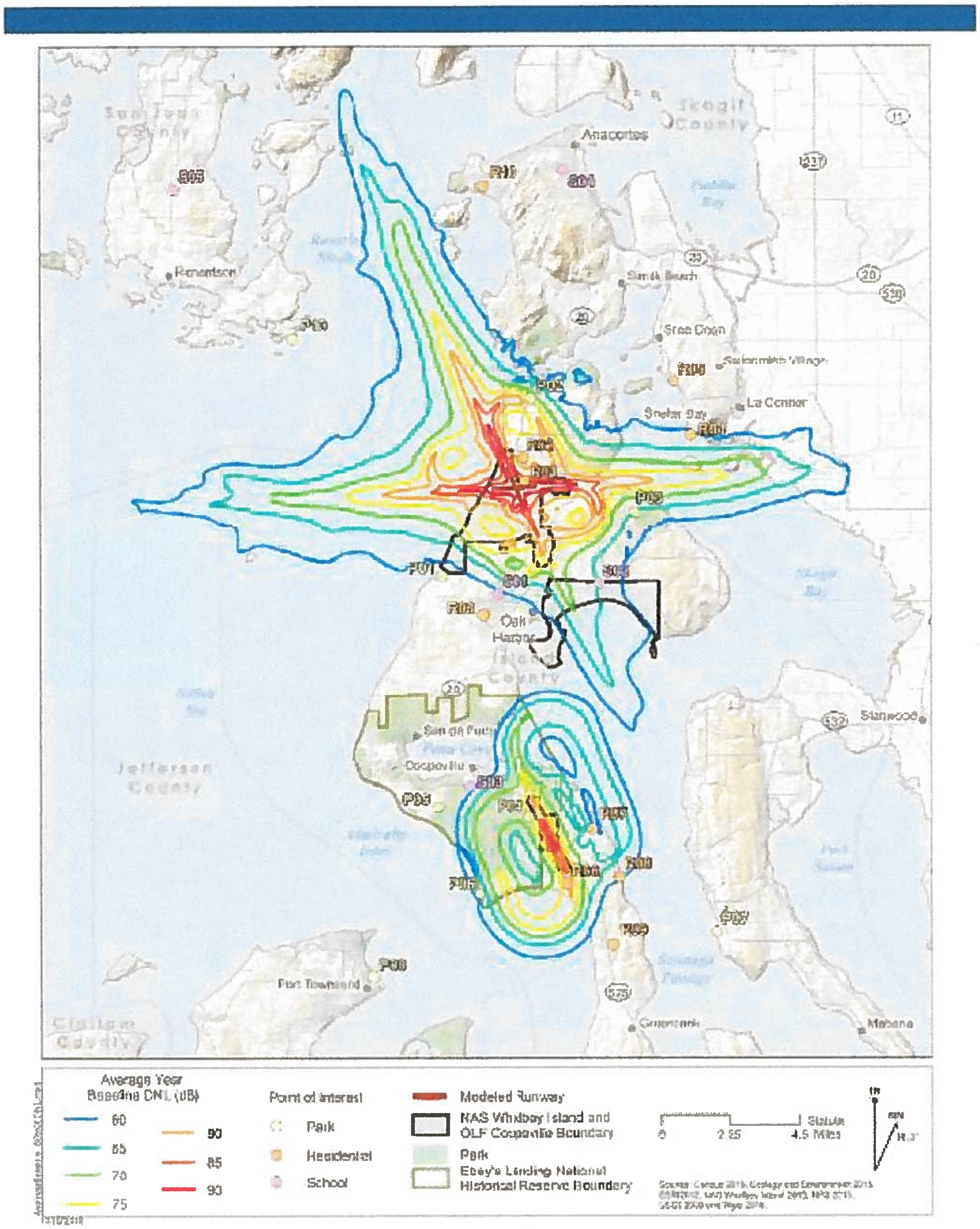

Figure 4-2. DNL Contours for AAD Aircraft Events for the Average Year Baseline Scenario

Appendix B: Articles on Non-auditory Effects of Noise on Children. Evans and Lepore 1993

Table 1. Effects of noise on cardiovascular outcomes

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Brackbill et al. (1982)	HR	1 h white noise for 4 consecutive days. 50 and 75 dBA.	(78 males) ages 1 mon. to 80 yrs.	In infants and 8-year olds, HR decreased as sound levels increased. No other main or interactive effects of noise.
Cohen et al. (1980)	BP	Aircraft. 95 dBA peak.	(262) grades 3 – 4.	Noisy-school children had higher SBP and DBP than quiet-school children.
Cohen et al. (1981)	BP	Aircraft. 95 dBA peak.	(163) grades 3 – 4, longitudinal sample.	In the longitudinal attrition sample, there were no effects of noise on BP.
Cohen et al. (1986)	BP	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grades 3 – 4, longitudinal sample.	SBP marginally lower and DBP significantly lower in quiet- than noisy-school children. SBP and DBP marginally lower in quiet- than noise-abated school children. No BP differences in children in noisy *vs.* noise-abated school.
Cohen et al. (1986)	BP	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children had higher BP than quiet-school children if were enrolled for 2 yrs or less. No noise effects on children enrolled more than 2 yrs.
Karsdorf & Klappach (1968)	BP	Traffic and street. 63 – 84 phon.	(262) grades 7 – 10.	Children in quiet schools had normal BP; whereas those in moderately- to very-noisy schools had elevated BP, especially among older boys.
Ising et al. (1990)	BP	Low altitude military flights. 125 dBA peak/Leq 68 dBA.	(433) ages 10 – 13 yrs.	Noise-related increases in SBP and DBP for girls, but not boys. Noise-related HR deceleration in boys and girls, but deceleration only significant in boys.
Karagodina (1969)	BP	Aircraft. 112 dBA peak/Leq 58 dBA.	(unavailable) ages 9 – 13 yrs.	Noisy-school children had higher BP than quiet-school children.
Roche et al. (1982)	BP	Self-report of exposure to loud noise sources. 80 – Leq.	(233) ages 12 – 14 yrs.	Self-reported noise exposure levels not associated with BP.

Note: HR = heart rate, BP = blood pressure, S = systolic, D = diastolic.

Table 2. Effects of noise on motivation (learned helplessness)

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Cohen et al. (1980)	Performance on moderately difficult puzzle after pretreatment with insoluble or soluble puzzle.	Aircraft. 95 dBA peak.	(262) grades 3 – 4.	Noisy-school children failed more on pretreatment soluble puzzle and difficult test puzzle, and were more likely to give up on difficult puzzle, than quiet-school children. There was a nonsignificant trend suggesting that longer exposure to a noisy school was associated with greater time to complete difficult puzzle.
Cohen et al. (1981)	Performance on moderately difficult puzzle.	Aircraft. 95 dBA peak.	(163) grades 3 – 4, longitudinal sample.	Noisy-school children were more likely to fail at the test puzzle and to take longer to solve the puzzle than quiet-school children. No noise effect on rate of giving up.
Cohen et al. (1981)	Performance on moderately difficult puzzle.	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grades 3 – 4, longitudinal sample.	Sound attenuation improved children's performance on the original test puzzle.
Cohen et al. (1986)	Performance on moderately difficult puzzle.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children failed difficult puzzle more frequently than did quiet-school children.
Cohen et al. (1986)	Choice task.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Noisy-school children more likely than quiet-school children to give choice of reward to experimenter.
Moch-Sibony (1984)	Rosenzweig frustration tolerance test.	Aircraft. 29 *vs* 54 SIL.	(80) kindergarten.	Noise-related decreases in frustration tolerance.
Wachs (1987)	Observer ratings of mastery-oriented play behavior.	Ratings of noise: 1 = normal level voices in home for 15 min. period to 4 = noisy level voices in home for more than half 15 min. period.	(88) 12 mon.	Less mastery-oriented play behavior in noisier homes.

Note: SIL = speech interference level.

Table 4. Effects of noise on auditory discrimination/speech perception

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Cohen et al. (1973)	WAD	Traffic and street. 55–66 dBA.	(54) grades 2–5.	Noise associated with poorer auditory discrimination.
Cohen et al. (1980)	WAD	Aircraft. 95 dBA peak.	(262) grades 3–4.	No effects of noise on auditory discrimination.
Cohen et al. (1986)	WAD	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	No effects of noise on auditory discrimination.
Moch-Sibony (1984)	MP	Aircraft. 29 *vs* 54 SIL.	(80) kindergarten.	Noise associated with poorer auditory discrimination.
		Acute noise		
Blue & Vergason (1975)	GFW	Recorded sounds (unspecified). 55 dBA.	(34) grades 1,3.	Race × Noise interaction: Black children's performance affected more negatively by noise than was white children's performance.
Nober & Nober (1975)	WAD	Recording of classroom noise *vs* ambient noise. 39.5–64.7 dBA.	(39) ages 5–7 yrs (healthy control, retarded, and speech-deficit).	Fewer errors when tested in quiet *vs.* normal classroom noise levels. Control and retarded children performed worse in noise than in quiet; speech-deficit group performed worse in noise than in quiet, but the effect was not significant.
McCroskey & Devens (1977)	WAD	Classroom noise recording. 4 dBA above ambient classroom noise	Unavailable.	Noise associated with decrements in auditory discrimination.
Glenn et al. (1978)	Speech discrimination	Recorded hospital sounds. 75 dB SPC (typical for hospitals).	(21) ages 9–14 yrs (institutionalized MR).	Noise mask significantly degraded speech discrimination.
Laraway (1985)	Digit discrimination	Intermittent white noise. 80 dB SPC.	(46) ages 5–21 yrs (CP, healthy controls).	Noise mask degraded performance of CP children but not controls. Noise effects greatest in younger (< 7 yrs) children.
Laskey & Tobin (1973)	Message comprehension	Speech and white noise. 74 dB SPC.	(22) ages 6–8 yrs (possible LD, non-LD controls).	Speech, but not white noise, interfered with auditory message comprehension in LD children. Control children unaffected by noise.

Note: WAD = Wepman auditory discrimination test, GFW = Goldman-Fristoe-Woodcock auditory discrimination task, MP = Massiot Phillips auditory discrimination test, SIL = speech interference level, LD = learning disabled, CP = cerebral-palsied, MR = mentally retarded.

Table 5. Effects of noise on resistance to auditory distractors

Author(s)	Outcome	Noise Source/Level	Sample Population (n)	Basic Result
		Chronic noise		
Cohen et al. (1980)	Cross-out letters in ambient or distracting (story recording) condition.	Aircraft. 95 dBA peak.	(262) grades 3–4.	Noise × Month enrolled interaction: with less than 2 yrs enrollment, noisy-school children performed better than quiet-school children under distraction. Between 2–4 yrs enrollment, no noise effects. With more than 4 yrs enrollment, noisy-school children performed worse than quiet-school children.
Cohen et al. (1981)	Cross-out letters in ambient or distracting condition.	Aircraft. 95 dBA peak.	(163) grades 3–4, longitudinal sample.	With 2–4 years enrollment, noisy-school children were less distracted than quiet-school children. With more than 4 yrs enrollment, performance was nearly the same across conditions.
Cohen et al. (1986)	Cross-out letters in ambient or distracting condition.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	Children attending noisy schools for 2–4 yrs were less distracted than their quiet-school counterparts. However, after 4 yrs enrollment, performance was nearly the same across conditions.
Cohen et al. (1981)	Cross-out letters in ambient or distracting condition.	Aircraft. 16 dBA reduction in noice-abated classrooms.	(163) grades 3–4, longitudinal sample.	No effects of noise abatement on distractibility.
Hambrick-Dixon (1986)	Weschler IQ task and match animals with color disks in quiet or noise conditions.	Train. 108 dBA peak.	(109 black) ages 4–6 yrs.	Children from noisy daycare performed better in noisy than in quiet conditions. The opposite was found for children from quiet daycare centers.
Heft (1979)	Figure discrimination in matching task in quiet or noise.	Story reading. Noise ratings: 1 = low to 7 = high.	(94) ages 4–7 yrs.	Auditory distraction had less of a negative effect on children from noisy homes than on children from quiet homes.
		Acute noise		
Turnure (1970)	Performance and glances away from a visual discrimination task.	Recording of child songs/stories. 60 dBA.	(30) ages 5.5, 6.5, 7.5 yrs.	No noise effects on glances, but performance worse in noisy than in quiet conditions.
Steinkamp (1980)	Multiple perceptual and cognitive tasks.	Classroom sounds and gadgets. Ambient noise.	(24) ages 6–8 yrs (hyperactive, non-hyperactive controls).	Classroom noise and distracting visual materials caused deficits on most tasks. No interaction with hyperactivity.

Table 6. Effects of noise on memory

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Hambrick-Dixon (1986)	Serial, incidental, visual, paired-associates learning.	Train. 108 dBA peak.	(109 black) ages 4–6 yrs.	No noise effects.
Heft (1979)	Incidental memory of visual stimuli.	Noise ratings: 1 = low to 7 = high.	(94) ages 4–7 yrs.	Higher household noise level associated with poorer incidental memory.
		Acute noise		
Fenton et al. (1974)	4 number digit-span.	White noise. 22–72 dBA.	(10 male) ages 9–11 yrs (LD and non-LD).	More errors made in the high noise than in the low noise conditions.
Hygge (1993)	Recall and recognition of reading passage.	Recorded simulations of aircraft, train, traffic, and verbal noise. 66–76 dBA.	(417) ages 12–14 yrs.	Within-subjects analyses revealed a marginal Noise × Source interaction: recall on difficult questions was lower among children in aircraft and traffic noise conditions than in control conditions; no differences in recall in train and verbal noise conditions relative to control condition. Between-subjects analyses also revealed a Noise × Source interaction: recall on difficult questions was lower among children in aircraft noise conditions than in controls; other noise sources did not affect recall. No noise effects on recognition task. Individual differences in learning ability did not moderate noise effects.
Johansson (1983)	Paired-associates learning and letter memory.	White noise. 51 dBA continuous; 55–78 dBA intermittent.	(66) age 10 yrs.	No noise effects.

Note: LD = learning disabled.

Author(s)	Outcome	Noise Source/Level	Sample Population (n)	Basic Result
Wachs et al. (1971)	IPDS	Noise ratings: 1 = normal level voices in home for 15 min. period to 4 = noise level voices in home for more than half 15 min. period.	(102) ages 7, 11, 15, 18, 22 mon.	Higher household noise associated with lower IPDS scores.
Wachs (1978)	SB	Ratings of noise: same as Wachs et al. (1971).	(23) ages 2–3 yrs, longitudinal.	Higher household noise associated with poorer SB performance in boys, no significant effect in girls.
Wachs (1979)	IPDS	Ratings of noise: same as Wachs et al. (1971).	(31) ages 2–3 yrs, longitudinal.	Higher household noise associated with lower IPDS scores in boys and higher IPDS scores in girls.
Wachs & Gandour (1983)	IPDS	Ratings of noise: same as Wachs et al. (1971).	(100) ages 7, 11, 15, 18, 22 mon.	Higher levels of household noise associated with lower IPDS scores, particularly in fussy and irritable infants.
Michelson (1968)	Language, spelling, and math.	Home environment ratings. Scale unavailable.	(710) grades 1–5.	Noise associated with language and spelling difficulties. Noise not associated with math achievement.
Maser et al. (1978)	Reading and math.	Aircraft. 90 dBA peak.	(1917) grades 3, 5, 7, 10.	Noise associated with reading and math deficits in 7th and 10th graders, but only marginal effects on 5th graders. Children with lower aptitudes were most adversely affected by noise.
		Acute noise		
Christie & Glickman (1980)	SPM	Recorded classroom noise. 40 and 70 dBA.	(156) grades 1, 3, 5.	Noise × Sex interaction: Boys performed better in noisy than in quiet conditions; girls performed better in quiet than in noisy conditions.
Johansson (1983)	Reading and math.	White noise. 51 dBA continuous, and 55–78 dBA intermittent.	(66) age 10 yrs.	Noise × Intelligence interaction on multiplication and reading performance. Above-average intelligence children solved more multiplication problems in noise than in quiet; below-average intelligence children showed the opposite trend, but noise effects were not significant. Below-average intelligence children tended to have poorer reading speed under noise; there was little difference in reading performance between noise groups with above-average intelligence.
Kassinove (1972)	Math.	Recorded child stories and music. 70–80 dBA.	(80) grades 3,6.	No noise effects on response latency, accuracy, or time-out from task.
Slater (1968)	Reading and math.	Ambient classroom noise, music, stomping and banging, tractor-mower, or quiet crossed with taped white noise. 45–90 dBA and 50–80 dBA white noise.	(263) grade 7.	No noise effects on speed or accuracy.

Table 7. Effects of noise on intellectual achievement

Author(s)	Outcome	Noise Source/Level	Sample Population (*n*)	Basic Result
		Chronic noise		
Bronzaft (1981)	Reading.	Train. 6 – 8 dBA sound reduction in noisy classrooms.	(955) grades 2 – 6.	After sound reduction with insulation on noisy side of school, students' reading scores on noisy side of school were equivalent to those of students on quiet side of school. In the year before insulation, students on noisy side of school had worse reading scores than students on quiet side of school.
Bronzaft & McCarthy (1975)	Reading.	Train. 59 – 89 dBA.	(161) grades 2, 4, 6.	Students' reading scores lower on noisy side of school than on quiet side, especially in higher grades.
Cohen et al. (1973)	Reading.	Traffic and street. 55 – 66 dBA.	(54) grades 2 – 5.	Noise associated with greater reading deficits in children living in apartments for 4 or more years.
Cohen et al. (1980)	Reading and math.	Aircraft. 95 dBA peak.	(262) grades 3 – 4.	No noise effects.
Cohen et al. (1981)	Reading and math.	Aircraft. 95 dBA peak.	(163) grade 3 – 4, longitudinal.	No noise effects.
Cohen et al. (1981)	Reading and math.	Aircraft. 16 dBA sound reduction in noise-abated classrooms.	(163) grade 3 – 4, cross-sectional.	Noise abatement results in 3rd grade only. Third graders in noise-abated classrooms performed better in math than 3rd graders in non-abated classrooms; 3rd graders in noise-abated classrooms also performed better in reading, but not significantly so.
Cohen et al. (1986)	Reading and math.	Aircraft. 95 dBA peak.	(165) grade 3, new sample.	No noise effects.
Gottfried & Gottfried (1984)	BSID, OP, MS, TELD	Noise ratings: 1 = normal level voices in home for 15 min. period to 4 = noise level voices in home for more than half 15 min. period.	(130) 12 mon. infants tested every 6 mon. up to 42 mon.	Higher household noise associated with lower scores on OP at 12 – 18 mon., on TELD at 39 mon., on BSID at 18 mon., and on MS scores at 42 mon.
Green et al. (1982)	Percent reading below grade level.	Aircraft. 96.2 dBA peak.	(8,240) grades 2 – 6.	Greater percentage of noisy-school children read below grade level. Effects strongest in higher grades.
Lukas et al. (1981)	Reading and math.	Traffic and street. 70 dBA peak.	(2500) grades 3,6 (100 classes sampled).	Reading scores lower for 3rd and 6th graders in noisier classes. Math scores lower in students in noisier 3rd grade classes, but higher in 6th grade students in noisier classes.
		Ambient classroom and community. 45 – 75 dBA.		Inverse correlations between community noise and math and reading scores were similar to but less consistent than those between classroom noise and math and reading scores. There also was a synergistic effect of home and school noise on reading.